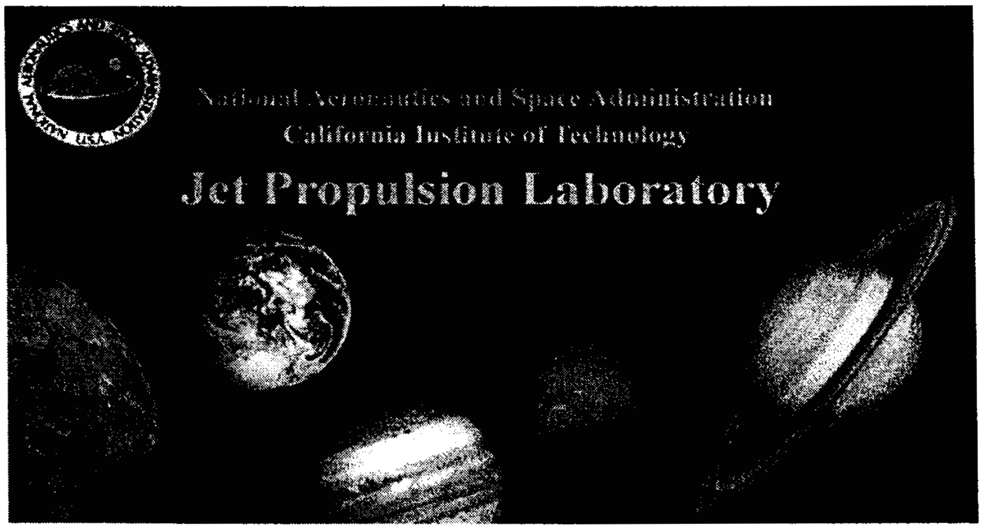
Military & Aerospace Applications of Programmable Devices and Technologies Conference

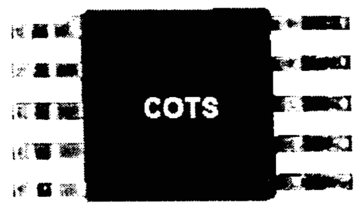
Goddard Space Flight Center

1998

JPL's Commercial Off-The-Shelf (COTS) Program

A Step Towards Infusion of Reliable COTS Plastic Parts in NASA Flight Hardware





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The Meaning of COTS

- "Buy and Fly"
- "Procuring via catalog part number to QML-V standards"
- "Procurement is performed without formal specification"
- "The usage of any COTS equipment does not constitute any waiver to fundamental applicable requirements"

JPL Interpretation:

COTS are parts whose specification is *manufacturer-controlled* as opposed to traditional "Hi-Rel"parts whose specification was *Government or customer-controlled*

Why Put COTS Plastic Parts in Space ?

1. The availability of COTS plastic parts is proliferating.

2. COTS plastic parts performance capabilities continue to increase (e.g. processing power & high density memories)

3. COTS plastic parts enable reduction of hardware weight and volume

4. COTS plastic parts typically cost much less than ceramic

5. COTS plastic parts have been reported to demonstrate good to excellent reliability in commercial and aerospace applications

6. Often they are the only option available to using state-of-the-art technologies

JPL's Concerns About Using COTS Plastic Parts

- Reliability/RH of Plastic in Space Applications
- Non Rad Hard Designed (maybe Rad Tolerant)
- Narrow Temperature Range for Commercial Grade
- Process/Designs Change Frequently
- Lack of Lot Traceability & Uniformity

Assessment Options for COTS Plastic Parts & Their Relative Tes

• Temperature/ Humidity	Corrosion	($)
• Temperature Cycling	Assembly Defects	($$)
• Moisture Absorption	Popcorning	($$)
• Radiation	TID Degradation	($$$$)
• Outgassing	Condensables	($)
• Glass Transition	Epoxy Stability	($$)
• Delamination	Voids/Stresses	($)
• Upscreening/Burn-in	Performance/Reliability	($$$$)
• DPA	Manufacturing Quality	($$)

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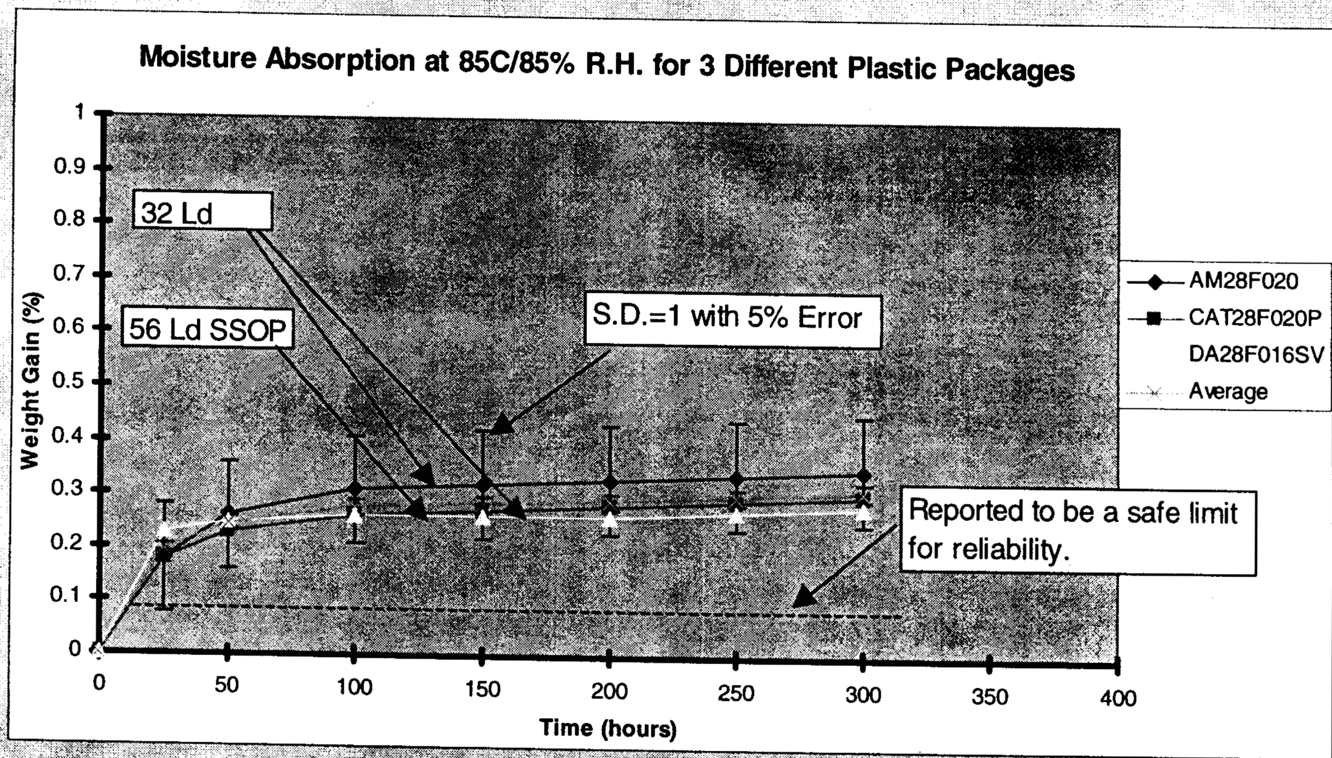
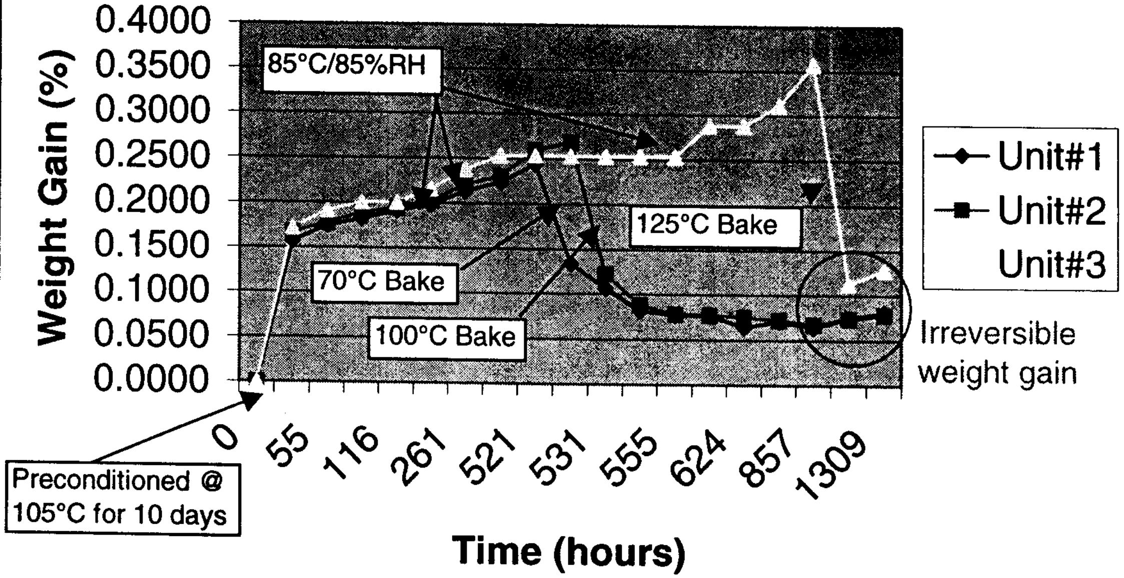


Conclusion: Most if not all plastic parts will absorb moisture >> 0.1% weight gain.

Moisture Absorption/Desorption for Intel 56 Ld SSOP Package



Note: Weight Gain (%) = (Wt-Wi)/Wi*100
Weight Loss (%) = (Wtd-Wi)/(Wf-Wi)*100

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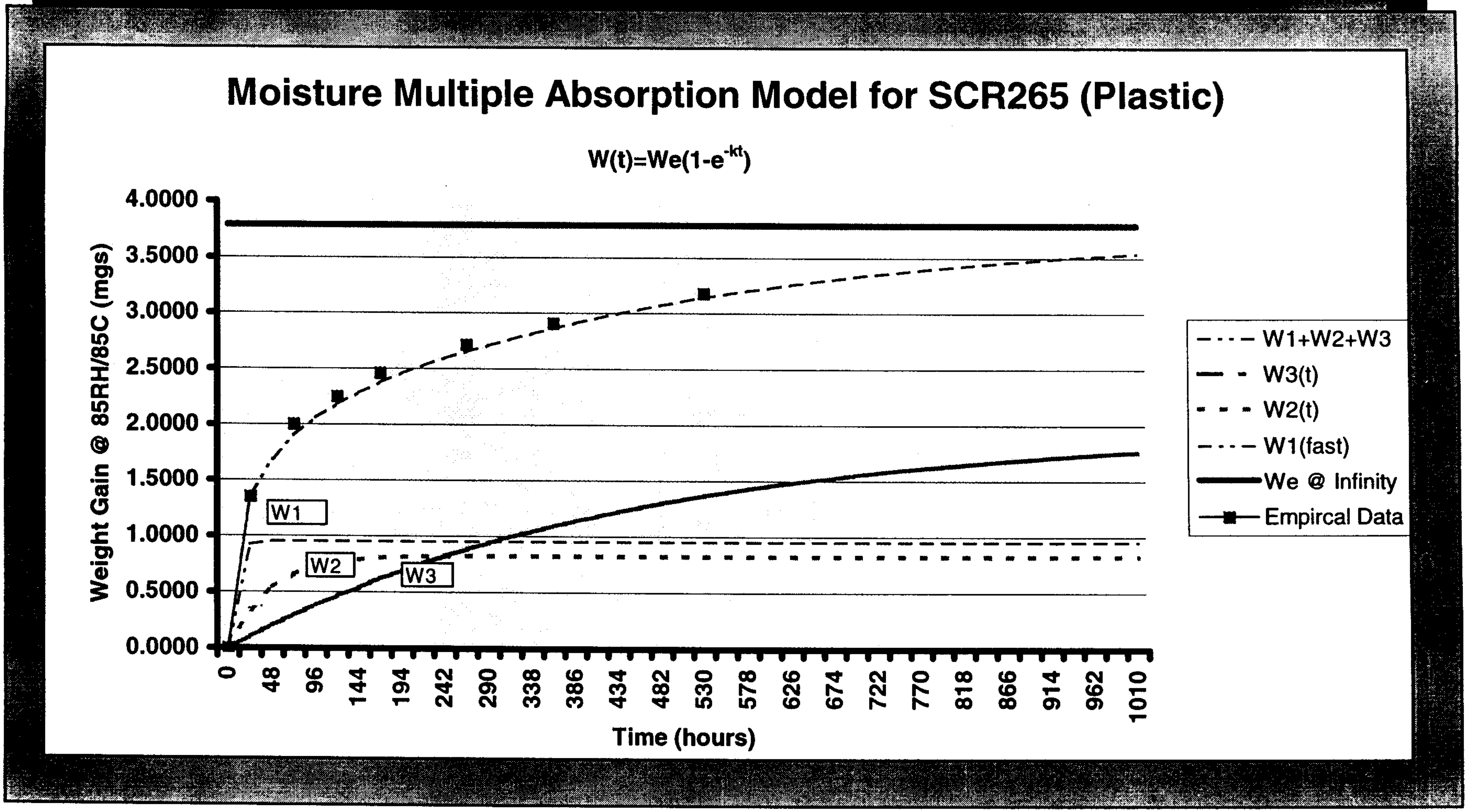

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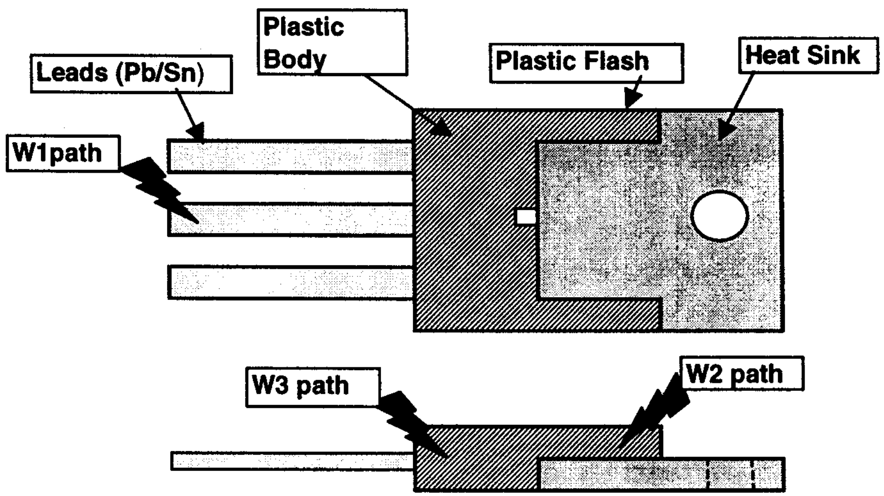
85%RH/85ºC Moisture Absorption Mechanisms for SCR265

- **W1(t):** Fast <u>Irreversible</u> Weight Gain ≤ 24 hours (~1mg)
- **W2(t):** Intermediate Reversible Weight Gain, 80 to 140 hours
- **W3(t):** Slowest Reversible Weight Gain, Reaches We @ t=∞

SCR265 Package



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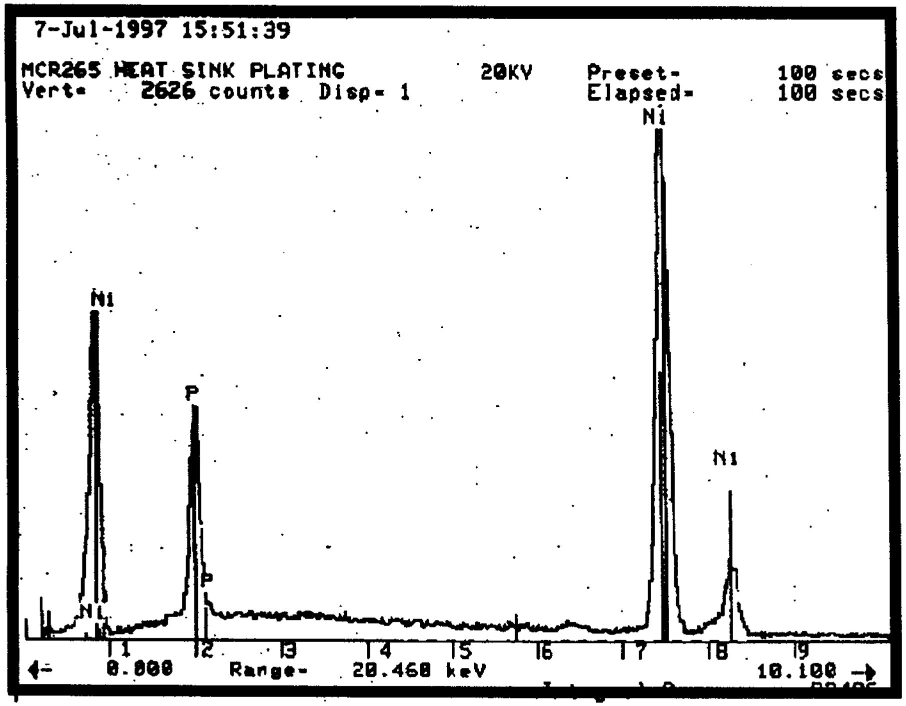
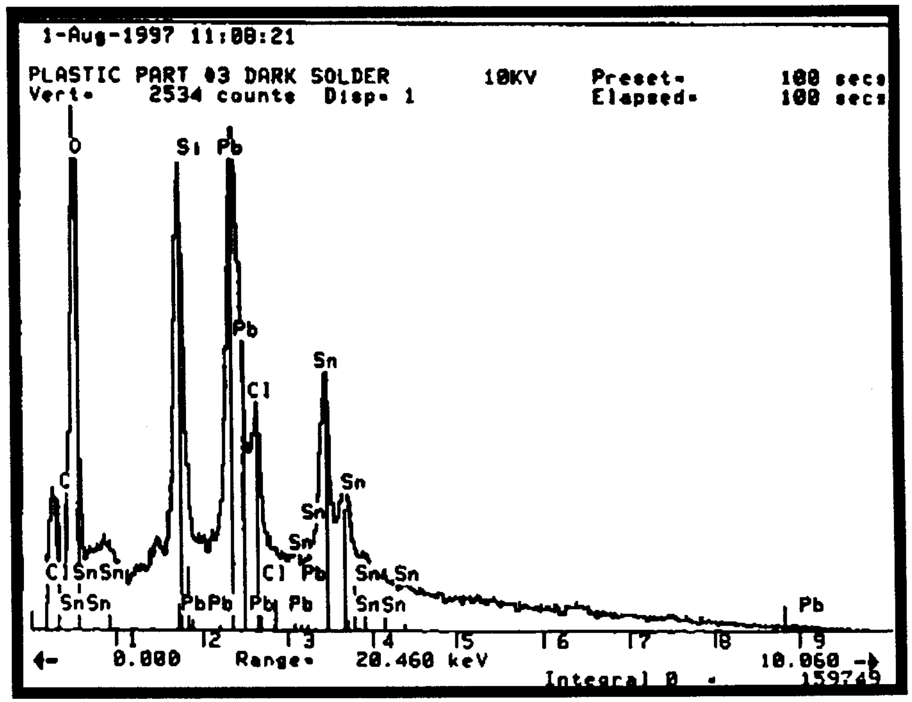
Nickel Plated Heatsink Shows No Oxidation

Post 85%RH/85ºC for SCR265

Leads Show Extreme Oxidation

➡ W1(t)





Conclusion: Weight gain is solely attributed to oxidation of leads. The internal chip has miniscule Al area available for oxidation because of Cu intermetallic bonding to the Al.

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Outgassing Test Flow for Plastic Packages

50% RH @ 25C for 24 hrs + Weighed → 5x10-5 torr @ 125C for 24 hrs → Collect Condensables on CP (25C) CVCM

→ Cool & Dry Test Chamber → Weigh Specimen & CP for TML → 50% RH @ 25C for 24 hrs + Weighed for WVR

Ref: ASTM E595-93

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Outgassing Results of Plastic Packages

Material	MCR			7612382FBA, E24, DA28F016SV, K8055, U6240332			AM28F020-150PC, 9618FBB			CSI, CAT28F020F, 1-15 09550B		
Part	Motorola SCR			Intel 16 M Flash Memory			AMD 2M Flash Memory			Catalyst 2M Flash Memory		
Sample No.	5	6		7	8	a	9	10		11	24	
WT. Loss %	0.45	0.46	0.45	0.23	0.22	0.22	0.41	0.45	0.43	0.40	0.41	0.40
Water Vapor Recovered, WVR, %	0.28	0.25	0.26	0.14	0.11	0.12	0.19	0.17	0.18	0.21	0.18	0.19
TML (WT, LOSS-WVR) %	0.17	0.21	0.19	0.09	0.11	0.10	0.22	0.28	0.25	0.19	0.23	0.21
CVCM %	0.04	0.08	0.06	0.02	0.01	0.01	0.03	0.05	0.04	0.04	0.04	0.04
DEPOSIT on CP	Opaque			Negligible			Opaque			Opaque		
FTIR Results	Amine cured epoxy			Anhydride cured epoxy			Amine cured epoxy			Amine cured epoxy		

Conclusion: All materials passed. These tests are suited for lot-to-lot comparisons, tracking manufacturing continuity/changes, and measuring absorbed moisture at a known environment.

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Radiation Results on Plastic Parts

Moisture Absorption / Bake for Intel DA28F016SV in Plastic Package

(0.6 μm ETOX IV Process Technology)

Conditions: Test Temperature = 25°C, Vdd = 5.0V, Vpp = 5.0V

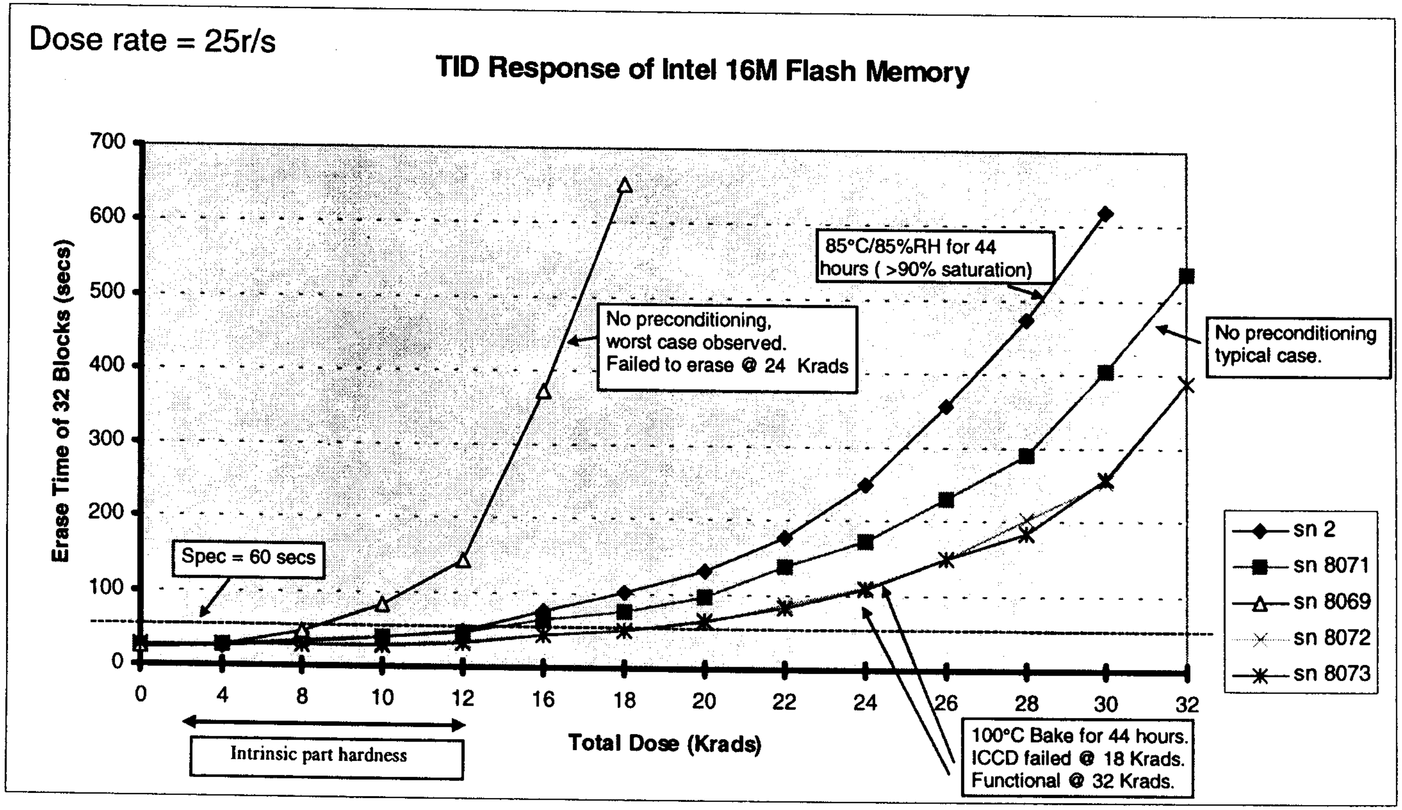

Figure 1
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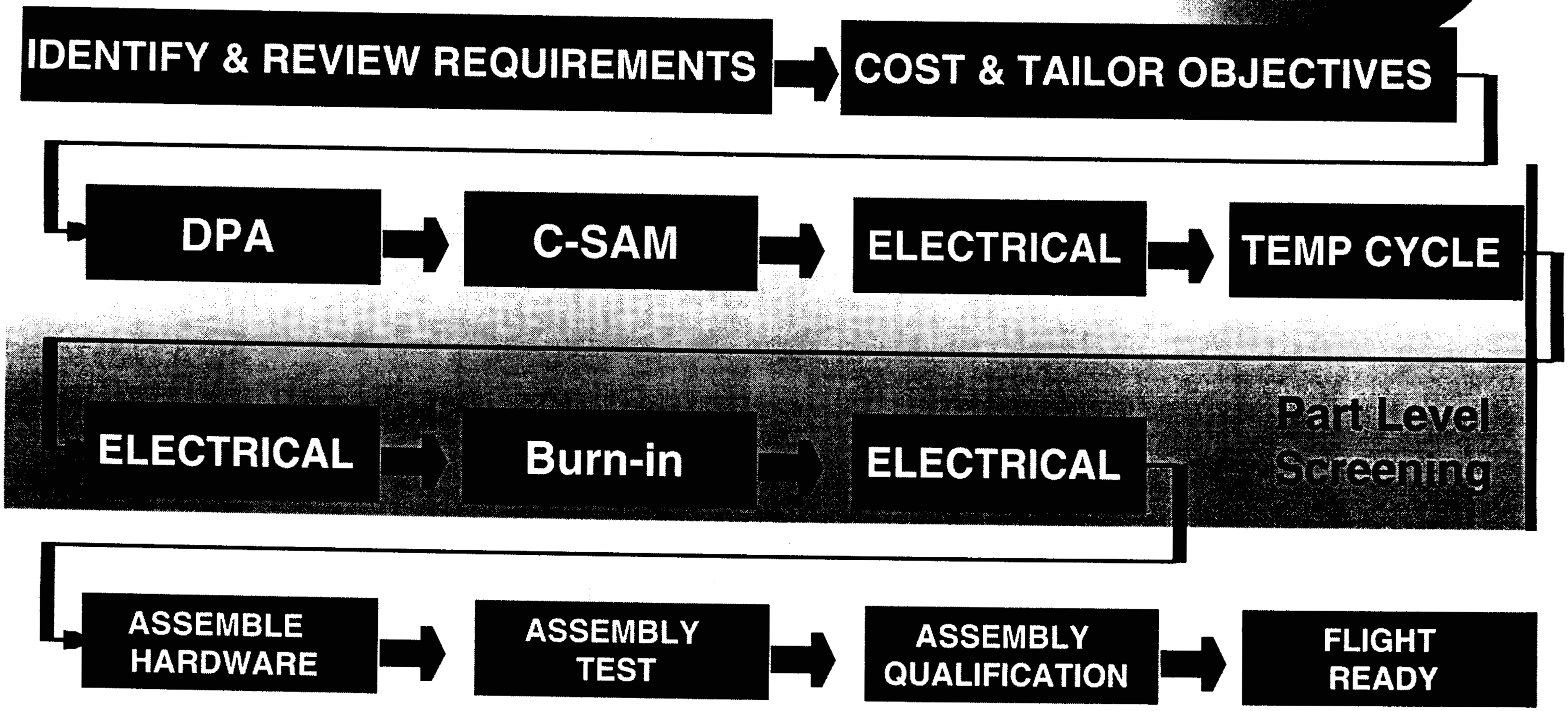

COTS Plastic Infusion Baseline Flow

In Summary

- Using COTS plastic parts without understanding their pedigree can lead to mission delay or worst ➡ **Mission Failure**
- A methodology is in place in Office 507 to help JPL users of plastic parts ascertain their risk and acceptance for Space Application
- Work is underway in Office 507 to evaluate **all risk factors** when using COTS plastic parts (quality, reliability, radiation,package).
- JPL is currently infusing plastic parts into flight hardware utilizing a **Better-Faster-Cheaper Program** tailored individually for each Project